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EMBEDDEDNESS OF SALMONID HABITAT OF SELECTED STREAMS ON THE PAYETTE NATIONAL FOREST 1985-1986

by
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PAYETTE NATIONAL FOREST

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INTRODUCTION

Comparison of fish habitat condition among various locations within the Payette National Forest is necessary in order to facilitate development of future management objectives for aquatic ecosystems. The single most significant element of fish habitat management during recent history has been development of objectives for limiting deposition of fine sediment. Three environmental impact statements within Forest during the past decade (Anon., 1977; Anon., 1979; Anon., 1981) have all dealt with the impact of sediment on fish habitat as a major issue. The development of another environmental impact statement pursuant to the implementation of the National Forest Management Act of 1976 (36 CFR 1950) is presently underway.

Embeddedness is generically defined as the amount of fine sediment which is deposited in the interstices between larger stream substrate particles. This fish habitat characteristic has been demonstrated by research (Klamt, 1976, Kelly and Dettman, 1980) to negatively influence the ability of a stream to rear fish. Increasing the amount of deposition, embeddedness, decreases the number of fish a stream can rear.

Stowell, Espinosa, Bjornn, Platts, Burns and Irving(1984) related increased embeddedness to man-caused sedimentation, as did Burns(1984) and Burns and Edwards(1985).

This inventory of embeddedness of fish habitat was conducted during 1985 and 1986, in order to empirically answer several questions.

1) Are there detectable sources of man-caused sediment, which could be detrimental to fish habitat, associated with the Thunder Mountain mining area ?

2) Are there detectable sources of man-caused sediment, which could be detrimental to fish habitat, associated with the Stibnite mining area ?

3) What is the condition of the mainstem South Fork Salmon River and its tributaries? This granitic watershed has been described by various authors (Anon., 1969; Anon., 1970; Knight, Thompson, Kulesza and Dean, 1974; Thompson, Skabelund and Kulesza, 1973).

4) What is the condition of Chamberlain Creek, a Salmon River tributary in the Frank Church-River of No Return Wilderness? The granitic nature of the watershed has been described in a National Forest report (Knight, Thompson, Kulesza and Dean, 1974).

STUDY AREA

Thunder Mountain Mining Area

Fifteen locations were identified surrounding the Thunder Mountain mining area (Table 1). These are the same as locations described by Burns and Edwards(1985). Two locations were established in Marble Creek, both upstream and downstream of Cottonwood Creek. Cottonwood Creek was established as a control, undisturbed by recent mining. Two locations were established in Big Creek, both upstream and downstream of Monumental Creek, in order to identify any influence in Big Creek. Control areas for Monumental Creek included Snowslide Creek, the West Fork of Monumental Creek, and Monumental Creek downstream from Annie Creek but upstream of most road reconstruction. Seven locations were established in Monumental Creek at various locations to establish the upstream and downstream extent of measurable increases in sediment deposition related to mining activities.

Stibnite Mining Area

Five locations were identified surrounding the Stibnite mining area (Table 2). These were in the same areas as those sampled by Burns(1984) in 1983, and Burns and Edwards(1985) in 1984. Two control areas were sampled, one in Tamarack Creek and one in Sugar Creek upstream of the mine in West End Creek. Three locations were sampled to determine the downstream extent of possible sediment deposition resulting from the West End mine.

South Fork Salmon River Drainage

Fifteen locations were identified in the mainstem South Fork Salmon River and its tributaries (Table 3). These locations were selected in an attempt to determine the extent of any changes from conditions described by Burns(1984) and Burns and Edwards(1985). The mainstem South Fork was sampled at the Glory Hole and upstream from Knob Creek. Two major tributaries, the lower Secesh River and East Fork were sampled. Smaller tributaries called "developed" by Burns(1984) were sampled, including Camp, Cow, Buckhorn, Fitsum and Zena Creeks. Tributaries called "partially developed" by Burns(1984) were sampled, including Elk, Lick and Pony Creeks. Tributaries called "undeveloped" by Burns(1984) were sampled, including Blackmare, Fourmile and Porphyry Creeks.

Chamberlain Creek

Six locations were identified in the Chamberlain Creek drainage (Table 4). Three locations were established in Chamberlain Basin and another three downstream in the vicinity of the confluence of Chamberlain and McCalla Creeks. These sites were selected to characterize a drainage with no significant roading or other major land disturbances.

TABLE 1. Embeddedness samples were taken from Big Creek and its tributaries, Monumental Creek and Marble Creek. These locations were picked to surround mining activity on Thunder Mountain. Samples above and below Mule Creek in Monumental Creek are similar locations to those sampled by Burns (1983). All locations were sampled by Burns and Edwards (1985). Legal descriptions are approximate. Burns took all measurements in 1985 and 1986.

Location	Township	Section	Range	Description
Marble Creek Upstream from Cottonwood Creek	18N	11NW1/4	11E	Pool tailouts approximately 200m upstream from the mouth of Cottonwood Creek
Cottonwood Creek	18N	11NW1/4	11E	Approximately 100m upstream from the confluence with Marble Creek.
Marble Creek downstream from Cottonwood Creek	18N	11	11E	Approximately 100m downstream from Cottonwood Creek.
Big Creek upstream from Monumental Creek	21N	17NE1/4	11E	Pool tailout about 100m upstream from the mouth of Monumental Creek.
Big Creek downstream from Monumental Creek	21N	16	11E	About 200m downstream from the mouth of Monumental Creek.
Monumental Creek downstream from Snowslide Creek	20N	6	11E	Pool tailout about 100m downstream from the mouth of Snowslide Creek.
Snowslide Creek	20N	6	11E	Pool tailout 10m upstream from Monumental Creek.
Monumental Creek downstream from Holy Terror Creek	20N	33	11E	About 400m downstream from the mouth of Holy Terror Creek at trail crossing.
Monumental Creek downstream from the West Fork of Monumental Creek	19N	5NE1/4	11E	About 400m downstream from the West Fork at trail crossing
West Fork of Monumental Creek	19N	8NW1/4	11E	Pool tailout about 100m upstream from Monumental Creek, at trail crossing.
Monumental Creek downstream from Mule Creek	19N	24NE1/4	10E	Pool tailout sampled 200m downstream from Mule Creek

Table 1.Cont'd.

Monumental Creek upstream from Mule Creek	19N	24NE1/4	10E	About 100m upstream from Mule Creek.
Monumental Creek upstream from Roosevelt Lake	19N	24SE1/4	10E	About 100m upstream from Roosevelt Lake.
Monumental Creek downstream from Coon Creek	19N	25	10E	Pool tailout downstream from Coon Creek.
Monumental Creek downstream from Annie Creek	18N	10NE1/4	10E	100m downstream from Annie Creek.

Table 2. Embeddedness samples were taken from the East Fork South Fork Salmon River (EF) vicinity. These locations were picked to "bracket" sediment input from an active open-pit mine near Stibnite, Idaho, in West End Creek (WE), and were sampled by Burns (1984) and Burns and Edwards (1985). Legal descriptions are approximate. Burns took all measurements in 1985 and 1986.

Location	Township	Section	Range	Description
EF downstream from Sugar Creek	19N	34	9E	Pool tailout in EF 200m downstream from Sugar Creek.
EF upstream from Vibika Creek	19N	27NW1/4	8E	In EF 10m upstream from Vibika Creek.
Sugar Creek downstream from WE	19N	34SE1/4	9E	In Sugar Creek upstream for FS road 48 bridge.
Sugar Creek upstream from WE	19N	35SE1/4	9E	In Sugar Creek 30m upstream from WE.
Tamarack Creek	19N	29NW1/4	9E	In Tamarack Creek upstream from FS road 48 bridge.

Table 3. Embeddedness sampling locations in the mainstem South Fork Salmon River and tributaries were selected in order to determine their relative condition. Some areas sampled by Burns (1984) and Burns and Edwards (1985) were selected for comparison. Legal descriptions are approximate. Burns took all measurements in 1985 and 1986.

Location	Township	Section	Range	Description
Blackmare Creek	17N	10SE1/4	6E	Downstream from old road crossing.
Buckhorn Creek	18N	4SW1/4	6E	20m upstream from South Fork.
Camp Creek	18N	15SW1/4	6E	Immediately upstream from FS road 674 bridge
Cow Creek	20N	19NE1/4	6E	100m upstream from mouth.
Elk Creek	21N	22NE1/4	7E	Upstream from FS road 340 bridge.
Fitsum Creek	19N	9NE1/4	6E	100m upstream from mouth.
Fourmile Creek	18N	26NW1/4	6E	Upstream from FS road 674 culvert.
Glory Hole Area	19N	16NE1/4	6E	In South Fork in a run 100m downstream from Glory Hole.
Lick Creek	20N	18SE1/4	6E	Vicinity of old bridge.
Lower East Fork	19N	30NW1/4	7E	Pool tailout at base of avalanche path 3.7km upstream from Forest highway 48 bridge.
Pony Creek	21N	2SW1/4	7E	Downstream from FS road 340 bridge.
Porphyry Creek	22N	9NE1/4	8E	50m upstream from mouth.
Secesh River downstream from Zena Creek	20N	33NE1/4	6E	Pool tailout at dispersed camp site 2km downstream from Forest highway 48 bridge.
South Fork upstream from Knob Creek	22N	17NE1/4	8E	Pool tailout on east side of river about 100m upstream from mouth of Knob Creek.
Zena Creek	20N	28NW1/4	6E	20m upstream from reservoir highwater.

Table 4. Embeddedness samples were taken from the Chamberlain Creek drainage in order to determine the condition of this relatively pristine granitic stream system. Legal descriptions are approximate. Burns took measurements in 1985.

Location	Township	Section	Range	Description
Chamberlain Creek	23N	2NW1/4	10E	100m upstream of footbridge on Chamberlain to Big Creek trail.
West Fork Chamberlain Creek	24N	26	10E	100m downstream from Game Creek.
Chamberlain Creek downstream from the West Fork	24N	31NW1/4	11E	200m downstream from mouth of the West Fork.
Chamberlain Creek upstream from McCalla Creek	24N	21NE1/4	12E	20m upstream from McCalla Creek.
McCalla Creek	24N	21NE1/4	12E	20m upstream from Chamberlain Creek.
Chamberlain Creek downstream from McCalla Creek	24N	15SW1/4	12E	400m downstream from the mouth of McCalla Creek.

METHODS

Methods for this inventory were adapted from Kelly and Dettman (1980),Burns (1984) and Burns and Edwards (1985). Data acquired could be entered into the General Aquatic Wildlife System (GAWS) of Region Four of the USDA-FS.

Embeddedness was earlier defined in generic terminology. For the remainder of this report embeddedness refers specifically to the proportion of a matrix particle (4.5 - 30.0 cm greatest diameter) surrounded by fine sediment (< 6.3 mm dia.) as described by Burns and Edwards (1985). Embeddedness is the proportion of a single matrix particle. A population of single matrix particles must be sampled in order to characterize fish habitat conditions in a quantitatively precise manner.

The standard of measurement was established as the closest millimeter. A sample size of 100 was selected as a minimum number of measurements for each population or location sampled. These standards were developed based on Burns'(1984) work and Burns and Edwards(1985). Tools used were those described by Burns and Edwards (1985).

Samples were taken systematically at each location in order to minimize the number of variables influencing measurement. Fish habitat was defined consistently among locations which would later be compared. All locations were sampled during baseflow or low flow conditions from mid-August through October . Criteria used to define fish habitat were developed from Bovee (1978) and further refined for this study and are defined in Burns and Edwards (1985).

Field techniques were those described by Burns and Edwards (1985). As a point of clarification all locations are pool tailouts, but the form varies from conditions similar to those described variously as runs or pocket water pools. A key similarity of all locations is that the area sampled was as central in the flow as possible in the transition out of a pool to the next downstream feature. Peripheral stream areas, point bars and negative velocity areas were rejected as sampling areas as described in Burns (1984). In small streams this leads to almost totally stratified sampling rather stratified random sampling.

RESULTS

Data were combined into four groups for one-way analyses of variance. Those groups were the Thunder Mountain mining area, the Stibnite mining area, the South Fork Salmon River drainage and the Chamberlin Creek drainage. Data collected by Burns and Edwards (1985) in 1984, were added to the analyses of variance for the Thunder Mountain, Stibnite and South Fork Salmon River groups. The analyses were run at the Fort Collins Computer Center using SPSS-X. For each of the groups the probability that the sample means for all years and locations were equal was less than 9 in 100,000. A pairwise comparison within each group was conducted using a least significant difference test (P=0.05). All references to significant differences between years or locations in this text is a result of the pair-wise comparison.

Thunder Mountain Mining Area

Mean embeddedness ranged from a low of 7% in Monumental Creek upstream from Mule Creek, immediately downstream from Roosevelt Lake in 1985, to a high of 44% in Monumental Creek downstream from Mule Creek in 1985 (Table 5). Means in the remainder of the area were generally 30% or less, with the exception of the Marble Creek drainage.

No location was significantly less embedded than Monumental Creek upstream from Mule Creek in 1985 when compared to other 1985 and 1986 data. All other locations were significantly less embedded than Monumental Creek downstream from Mule Creek in 1985 when compared to other 1985 and 1986 data. Monumental Creek downstream from Mule Creek could not be distinguished from control locations in 1986.

Stibnite Mining Area

Mean embeddedness in the Stibnite area ranged from a low of 14% in Tamarack Creek in 1986 to a high of 44% in Sugar Creek downstream from West End Creek in 1985 (Table 6).

No locations were significantly less embedded than Tamarack Creek and the East Fork upstream from Vibika Creek in 1985 and 1986. Those two locations were both significantly less embedded than the East Fork downstream from Sugar Creek or Sugar Creek downstream from West End Creek when 1985 and 1986 data are compared. Sugar Creek downstream from West End Creek was significantly less embedded in 1986 than in 1985.

South Fork Salmon River Drainage

Mean embeddedness ranged from a low of 8% in Porphyry Creek in 1985 to a high of 58% in the Glory Hole area in 1986 (Table 7). Locations with sample means in excess of 40% included Camp Creek in 1986, Cow Creek in 1986, the Glory Hole area in 1986, and the South Fork upstream from Knob Creek in 1985 and 1986.

The Glory Hole area was significantly more embedded than all other locations in the South Fork for 1985 and 1986 data. Cow Creek in 1986 was significantly more embedded than any other South Fork tributary in 1986. Camp Creek in 1986 was significantly more embedded than all other tributaries in 1986 except for Pony and Buckhorn Creeks, which were not different and Camp Creek which was more embedded. The South Fork upstream from Knob Creek was not significantly different in 1985 and 1986.

Table 5. Mean embeddedness ranged from a low of 7% in Monumental Creek immediately downstream of Roosevelt Lake in 1985, to a high of 44% immediately downstream of Mule Creek in 1985. Means in the rest of the Thunder Mountain mining area were generally less than 30% in undisturbed areas, with the exception of the Marble Creek drainage. The number of samples is equal to the number of matrix particles measured.

LOCATION	YEAR	NUMBER OF SAMPLES	MEAN EMBEDDEDNESS	95% CONFIDENCE INTERVAL ON THE MEAN
Marble Creek upstream from Cottonwood Creek	1985	117	31	26 - 36
Marble Creek downstream from Cottonwood Creek	1985	116	26	20 - 32
Cottonwood Creek	1985	114	31	25 - 37
Big Creek upstream from Monumental Creek	1985	111	18	12 - 23
Big Creek downstream from Monumental Creek	1985	110	11	8 - 15
Monumental Creek downstream from Snowslide Creek	1985	118	14	9 - 18
Snowslide Creek	1985	137	12	8 - 16
Monumental Creek downstream from	1985	135	13	8 - 17
Holy Terror Ck.	1986	118	12	8 - 17
Monumental Creek downstream from the West Fork of	1985	104	15	10 - 21
Monumental Creek	1986	100	18	12 - 24
West Fork of	1985	113	15	10 - 20
Monumental Creek	1986	119	21	15 - 26
Monumental Creek downstream from	1985	107	44	38 - 49
Mule Creek	1986	100	19	14 - 25
Monumental Creek upstream from	1985	105	7	3 - 11
Mule Creek	1986	104	10	5 - 15

Table 5. Con't.

LOCATION	YEAR	NUMBER OF SAMPLES	MEAN EMBEDDEDNESS	95% CONFIDENCE INTERVAL ON THE MEAN
Monumental Creek upstream from Roosevelt Lake	1985	127	23	17 - 28
Monumental Creek downstream from Coon Creek	1985	102	19	14 - 25
	1986	121	18	13 - 22
Monumental Creek downstream from Annie Creek	1985	101	24	19 - 30
	1986	122	25	19 - 31

Table 6. Mean embeddedness in the Stibnite mining area ranged from 14% in Tamarack Creek in 1986 to 44% in Sugar Creek below West End Creek in 1985. The number of samples is equal to the number of matrix particles measured.

LOCATION	YEAR	NUMBER OF SAMPLES	MEAN EMBEDDEDNESS	95% CONFIDENCE INTERVAL ON THE MEAN
East Fork downstream from Sugar Creek	1985	106	34	28 - 40
	1986	107	30	24 - 36
East Fork upstream from Vibika Creek	1985	129	18	12 - 23
	1986	108	20	15 - 25
Sugar Creek downstream from West End Creek	1985	100	44	39 - 50
	1986	113	30	25 - 36
Sugar Creek upstream from West End Creek	1985	104	27	21 - 32
	1986	100	36	31 - 41
Tamarack Creek	1985	120	18	12 - 26
	1986	125	14	10 - 19

Table 7. Mean embeddedness in the South Fork Salmon River drainage ranged from a low of 8% in Porphyry Creek in 1985 to a high of 58% in the Glory Hole area in 1986. The number of samples is equal to the number of matrix particles measured.

LOCATION	YEAR	NUMBER OF SAMPLES	MEAN EMBEDDEDNESS	95% CONFIDENCE INTERVAL ON THE MEAN
Blackmare Creek	1986	115	32	27 - 37
Buckhorn Creek	1986	110	34	29 - 39
Camp Creek	1986	105	43	38 - 48
Cow Creek	1986	119	50	46 - 54
Elk Creek	1985	103	13	8 - 18
	1986	117	20	16 - 25
Fitsum Creek	1986	105	25	20 - 30
Fourmile Creek	1986	107	17	12 - 22
Lick Creek	1986	116	19	15 - 23
Lower East Fork	1986	110	34	29 - 39
Glory Hole area	1986	101	58	54 - 63
Pony Creek	1985	110	34	28 - 40
	1986	100	28	23 - 33
Porphyry Creek	1985	115	8	4 - 12
	1986	103	25	20 - 31
Secesh River downstream from Zena Creek	1986	105	39	34 - 45
South Fork upstream from Knob Creek	1985	122	47	42 - 53
	1986	108	44	38 - 49
Zena Creek	1986	100	32	26 - 38

Chamberlain Creek

Mean embeddedness ranged from a low of 15% in Chamberlain Creek to a high of 27% (Table 8). The high of 27% occurred in McCalla Creek and in Chamberlain Creek downstream from McCalla Creek. No location had a sample mean in excess of 30%.

McCalla Creek and Chamberlain Creek downstream were the only two locations which were significantly different than other locations. They were significantly more embedded than Chamberlain Creek, West Fork Chamberlain Creek and Chamberlain Creek upstream from McCalla Creek.

Table 8. Mean embeddedness in the Chamberlain Creek drainage ranged from a high of 27% to a low of 15%. All data was collected in 1985. The number of samples is equal to the number of matrix particles measured.

LOCATION	NUMBER OF SAMPLES	MEAN EMBEDDEDNESS	95% CONFIDENCE INTERVAL ON THE MEAN
Chamberlain Creek	102	15	11 - 20
West Fork Chamberlain Creek	107	16	12 - 20
Chamberlain Creek downstream from the West Fork	107	20	14 - 26
Chamberlain Creek upstream from McCalla Creek	100	19	15 - 24
McCalla Creek	110	27	21 - 33
Chamberlain Creek downstream from McCalla Creek	102	27	21 - 33

DISCUSSION

Thunder Mountain Mining Area

The Marble Creek drainage generally had moderate levels of embeddedness in 1985, ranging in sample means from 26% to 31%. Burns and Edwards (1985) reported sample means ranging from 30% to 37%. No important differences were apparent between years. Because of this and the distance between the sampling locations and potential sources of man-caused sediment, the locations were not sampled in 1986. In addition, beaver dams obstruct major portions of Marble Creek between potntial man-caused sediment sources and the sample locations.

The very low level of embeddedness found in Monumental Creek upstream from Mule Creek, immediately downstream from Roosevelt Lake, is not suprising. Roosevelt Lake should act as an efficient sediment trap. Burns(1983) noted that the area immediately upstream of Mule Creek was 15% embedded in 1983. The area he sampled was about 100 meters downstream of the location where mean embeddedness was estimated to be 5% in 1984 by Burns and Edwards (1985). Liming(1984) reported this same stream reach to contain 18% fine sediment less than 6.3 mm diameter, based on core samples taken in 1983. Sample means were 7% in 1985 and 10% in 1986. There were no significant differences amoung 1984, 1985 and 1986.

Effluent from Mule Creek had flushed from the stream bed of Monumental Creek in 1986. Burns(1983) reported embeddedness of 45% downstream of Mule Creek in 1983 in the same location where Burns and Edwards (1985) in 1984 had a sample mean of 51%. Liming(1984) showed 45% fine sediment less than 6.3 mm diameter, based on core samples taken in 1983. Sample means were 44% in 1985 and 19% in 1986. The 1986 sample mean was significantly less than either 1984 or 1985, but was not significantly different from most control locations.

A comparison of Monumental Creek immediately upstream and downstream from Mule Creek demonstrates that Mule Creek effluent continued to severely degrade fish habitat through 1985, but was flushed from the stream by the high flows in 1986. Large amounts of new fine sediment were not observed to be produced by Mule Creek in 1986.

Stibnite Mining Area

Mean levels of embeddedness in Sugar Creek downstream from West End Creek were significantly less in 1986 than they had been for previous years. The mean of 44% in 1985 and 48% (Burns and Edwards, 1985) in 1984 were both significantly higher than the 1986 value of 31%. Burns(1984) reported 50% embeddedness in this location in 1983. The 1986 value is similar to upstream "controls", which have ranged from 26% (Burns and Edwards,1985) in 1984 to 36% in 1986. Flushing of the area downstream is probably the result of little new sediment input from the West End mine during the previous year, due to the location of a new waste dump and lack of severe storms, combined with a relatively high spring runoff.

South Fork Salmon River Drainage

Few important changes were noted in the South Fork Salmon River basin. Areas in poor condition, where sample means exceeded 38%, in Camp Creek, Cow Creek, the Secesh River downstream from Zena Creek, the South Fork downstream from Knob Creek and the Glory

Hole area remained about the same as described by Burns (1984) and Burns and Edwards (1985).

Three "developed" drainages improved from the conditions reported by Burns (1984) in 1983. Buckhorn Creek had sample means of 41% in 1983 and 34% in 1986. Fitsum Creek had sample means of 43% in 1983 and 25% in 1986. Zena Creek had sample means of 48% in 1983 and 32% in 1986. There is insufficient data to draw any conclusion about time trends. It is likely that the results reflect the high peak runoff in 1986 which was combined with few winter or spring rain storms. The mass failures from old roads which occured in the winter and spring of 1981-82 were not observable in Buckhorn, Fitsum and Zena Creeks in 1986. Erosion was obvious on newer roads in the Cow Creek drainage and it is tempting to conclude that Cow Creek did not improve for that reason, but the evidence is not conclusive.

A large wildfire in the Elk Creek drainage during the summer of 1985 did not result in significant changes in embeddedness in Elk Creek through 1986. Elk Creek and the South Fork upstream from Knob Creek were sampled in 1985 and 1986 to try and evaluate fire impacts as were controls in Pony Creek and Porphyry Creek.

Blackmare Creek exhibited a sample mean of 32% in 1986, which is a significant increase from the mean in 1984 of 21% reported by Burns and Edwards (1985). This increase is likely due to the storm discussed by Burns and Edwards (1985). Erosion products of the storm were likely transported to the sample reach by the high peak runoff of 1986. Adjacent, "undeveloped", control drainages did not exhibit important differences for the years of available data.

The results of this study are consistent with the works of Lund (1982) and Corley and Newberry (1982) which show higher amounts of sediment deposition in the mainstem South Fork than other areas such as the Secesh Basin. Megahan, Platts and Kulesza (1980) described the history of changing conditions in the South Fork.

Chamberlain Creek

Chamberlain Creek exhibited good fish habitat conditions, with sample means all less than 30%. These results are consistent with those of Lund (1982a) who reported sample means of 25% for fine sediment less than 6.3mm in Chamberlain basin as a result of core sampling. It is also consistent with the results of Burns (1984) who reported sample means less than 30% in "undeveloped" drainages. Burns and Edwards (1985) and this study generally found undeveloped drainages with sample means of less than about 34%.

General Observations

Several general observations were made by the author during the course of the survey and subsequent analyses. The following is a brief summary of some key considerations:

1.) Stream energies are apparently generally sufficient to cleanse streams of severe emdeddedness, provided that major sources of fine material are absent. This is evident in the data and observations on the two mining areas and the South Fork. If energies were insufficient to break up the armour layer, then none of the heavily embedded locations would have exhibited cleansing.
2.) If embeddedness is used as part of any analysis to relate modeled sediment yield to fish habitat, care must be taken to get data during appropriate water years. Sample means for "developed" drainages ranged from 36% to 50% in 1983 (Burns, 1984) in the South Fork and from 25% to 50% in 1986 in the same drainages. Such variability can lead to ambiguous results. Data sets used to evaluate fish habitat impacts should include years with major erosion causing storms in thier recent past.
3.) Multiple controls are mandatory to account for events such as the Blackmare storm.
4.) At least five years of consecutive data are needed to evaluate time trends in embeddedness, because of the year to year variability in data from individual locations. Year to year variability is at least as great as reported by Corley and Newberry (1982) for core sampled substrate characteristics. This kind of variability should be expected because of the relationship between core sample results and embeddedness (Burns, 1984).
5.) In order to more conclusively demonstrate cause and effect relationships between erosion sources and embeddedness, data should be collected prior to implementing land disturbances. Data presented in this report demonstrate that in the absence of obvious erosion, streams can cleanse themselves. However, it is not absolutely certain how much erosion results in a specific high level of embeddedness, because of a lack of data collection prior to some land disturbances.

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